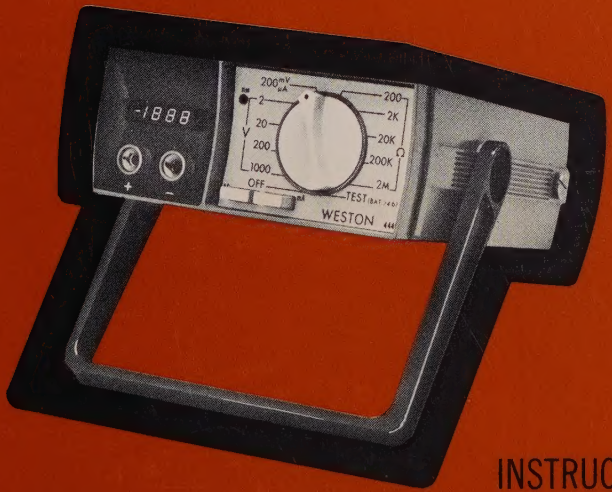
MODEL 4440 DIGITAL MULTIMETER



INSTRUCTIONS / PARTS LIST

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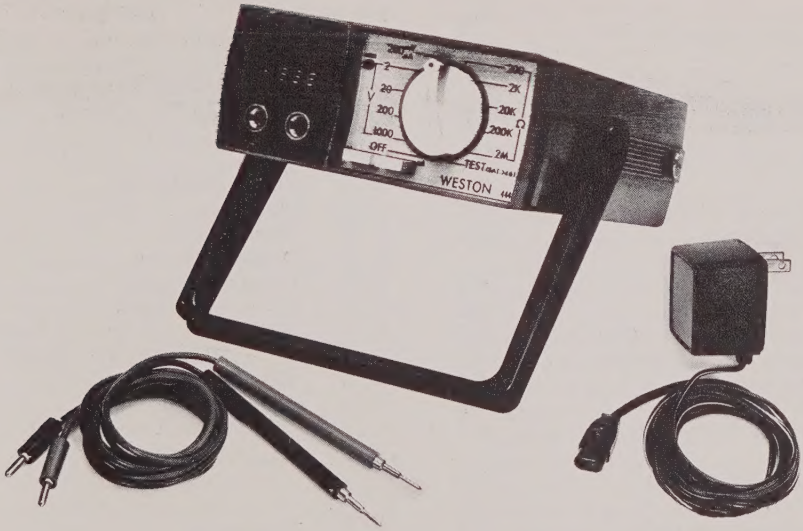
MODEL 4440



DIGITAL MULTIMETER
WITH TEST LEADS AND BATTERY CHARGER

U.S. Patent 3,051,939 and Patents Pending
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WESTON INSTRUMENTS, INC.
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Newark, New Jersey 07114

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SECTION 1

GENERAL INFORMATION

DESCRIPTION

The Weston Model 4440 is a 3½ digit solid state portable Digital Multimeter (DMM) designed for either field use or laboratory applications. The Model 4440 DMM is light-weight and shock-proofed. It is self-contained in a high-impact resistant plastic case. The carrying handle serves a dual purpose as a tilt-stand. The unit may be panel mounted using accessory brackets.

Four self-contained rechargeable (and easily replaced) nickel cadmium C cells provide a minimum of eight (8) hours of continuous operation. A plug-in battery charger provides for normal line operation both while the batteries are being recharged and to maintain the batteries in a full charged state. The DMM can also be operated using standard carbon type C cells.

Seventeen ranges at 3½ digit resolution cover 200.00 millivolts to 1000 volts AC/DC, 200.0 ohms to 2 megohms, plus 200.0 microamperes AC and DC current.

The basic measuring circuit is a high impedance bipolar analog-to-digital converter using a patented dual-slope integration to achieve accuracy and long term stability. The basic DC measurement ranges are 200 millivolts and 2 volts. An attenuator is used on all other ranges.

AC voltage is converted to DC by an average sensing, RMS-calibrated, operational rectifier. Currents are measured by the voltage drop across a shunt. Full scale indications are produced with a maximum voltage drop of 200 millivolts. Resistance is measured by passing a scaled constant current through the unknown resistance and measuring the DC voltage across it. The maximum current is 1 milliampere. The 2KΩ, 20KΩ, and 2 megohm ranges provide a maximum voltage drop across the unknown of 2 volts (allowing forward biasing of semi-conductor junctions in continuity tests).

The Model 4440 is designed for ease of operation. There are only two front panel jacks, a rotary range-function switch, and two push-buttons to select DC/AC and/or current measurements. No switching is required to select battery, line operation, or battery recharge.

Special features of the Model 4440 include a custom-designed plug-in solid state LED readout, a single MOS LSI plug-in chip for all logic circuit functions, auto-polarity, automatic blanking of unused digits to conserve battery power and improve display readability, overload protection with spare fuses, and over-range indication. The front panel range switch includes a battery test position to accurately measure the internal battery voltage. Also, in this test position most of the segments are flashed on and off to remind the user of the position of the range switch. The flashing segments also provide an indication of most segment control and LED display failures.

SECTION 2

SPECIFICATIONS

Display: .....
Maximum Count: 1999
Overrange Indication: Automatic beyond 1999 blinking 1 in thousands place, polarity indication, and decimal point.
Polarity Indication: Automatic, Negative "–"
Reading Rate: Approximately 4 per second, non-blink
Numeric Display: .19" character size, seven segment LED with integral decimal points.

Power Requirement .
105 to 130 VAC
(210 to 260 VAC optional)
Line Frequency: 50 to 400 Hz
Power Drain: 5 watts into charger, nominal 0.75 watt at 5.0V into DMM, nominal

Power Line Isolation: ....
May be operated 1500V above power line ground (during line operation).

Operating Temperature: .
0°C to 50°C Battery operation
5°C to 45°C Line operation
5°C to 40°C Charging with DMM off

Accessories ..
Battery Charger –
105 to 130 VAC, Part No. 272968-901 std equip. for meter Catalog No. 4440-273160
(210 to 260 VAC, Part No. 273426-901 optional)
Test leads – std equip. Part No. 270066-001
Hardware, Panel Mtg – optional Part No. 187205-953
Batteries – std equip. Four C size nickel cadmium Part No. 274120-001 or equivalent
Carrying Case – optional Catalog No. 9740-273454

Storage Temperature .
–40°C to 50°C (upper temperature limited by batteries, 70°C without batteries)

Normal Mode Rejection: ...
35 dB minimum at 50 Hz

Common Mode Rejection: ...
80 dB (line operation)
Extended on battery operation

Size: .....
2.26"H x 5.43"W x 7.01"D
(57.40 mmH x 137.92 mmW x 178.05mmD)

Weight: .....
2½ pounds (1.14 kg)

DC VOLTS

Range	*Zin*	*Accuracy, 25°C ±10°C*	*Overload Protection (Resistance and Clamping Diodes)*
199.9mV	50MΩ	±.3% Rdg ±1 digit	300V
1.999V	500MΩ		300V
19.99V	10MΩ		1100V
199.9V	10MΩ		1100V
1000V	10MΩ		1100V

Step Response: 2 seconds
Input Bias Current: 7 nA Maximum
Temperature Influence: 200 ppm/°C

AC VOLTS (Mean sensing, RMS Calibrated)

Range	*Zin*	*Accuracy, 25°C ±10°C*	*Overload Protection (Resistance and Clamping Diodes)*
199.9mV	10MΩ 150 pF	±.5% Rdg. ±3 digits 40 Hz to 10K Hz	250V RMS
1.999V			250V RMS
19.99V			1000V RMS
199.9V			1000V RMS
1000V		±.5% Rdg ±3 digits 40 Hz to 2K Hz	1000V RMS

Step Response: 5 seconds
Temperature Influence: 300 ppm/°C

RESISTANCE

Range	*Measuring Current*	*Accuracy, 25°C ±10°C*	*Overload Protection (Clamping on positive polarity, fuse on negative polarity)*
199.9Ω	1mA	±.5% Rdg ±3 digits	250V RMS
1.999KΩ	1mA		250V RMS
19.99KΩ	.1mA		250V RMS
199.9KΩ	1μA		250V RMS
1.999MΩ	1μA		250V RMS

Step Response: 2 seconds
except 2MΩ 15 seconds
.2MΩ 3 seconds
Temperature Influence: 300 ppm/°C

DC CURRENT

Range	*Accuracy, 25°C ±10°C*	*Overload Protection (fuse)*
DC 199.9μA	±.4% Rdg ±1 digit	30mA
AC 199.9μA	±.7% Rdg ±3 digits 40 Hz to 10K Hz	30mA

Temperature Influence: 250 ppm/°C

SECTION 3

INSTALLATION

GENERAL

Inspect the instrument for possible damage in shipment. If damage is noted, notify the carrier and supplier before using the instrument.

CARRYING HANDLE-TILT STAND

The handle incorporates a detent mechanism to provide a flexible tilt-stand.

PANEL INSTALLATION

The instrument is provided with an option for mounting on a panel. Special mounting hardware is available under Part No. 187205-953. The dimensional drawing is shown in Figure 3-1 and panel cut-out dimensions are given in Figure 3-2.

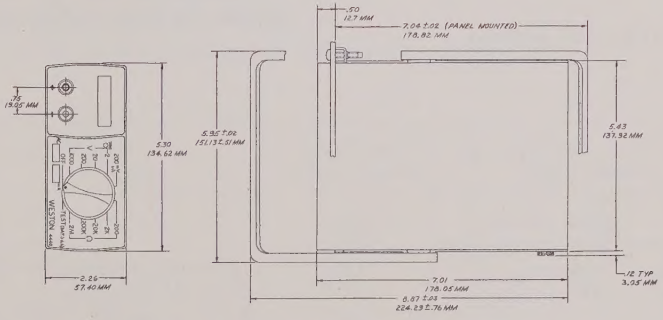


Figure 3-1. Dimensional Drawing

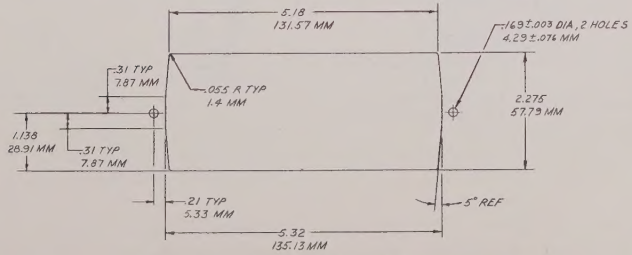


Figure 3-2. Panel Cut-Out Dimensions

SECTION 4

OPERATION

BATTERY OPERATION

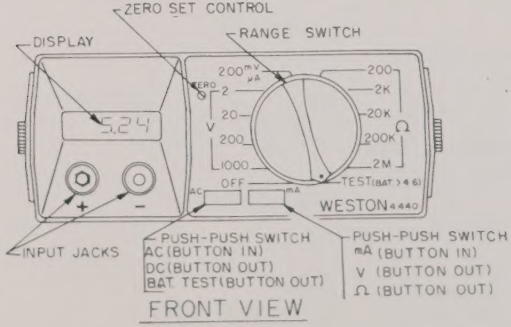
The digital multimeter (DMM) will operate on its internal batteries. The state of charge should be checked periodically by following these steps.

NOTE: The instrument is shipped from the factory with the batteries discharged. See AC OPERATION AND RECHARGING for charging procedure.

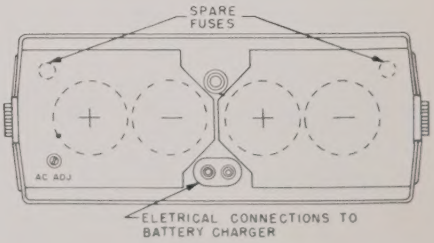
1. Set RANGE SWITCH in TEST position.
2. Set to AC pushbutton switch in DC position (button OUT).
3. Display shall be greater than 4.60 volts.

If either the battery voltage is close to 4.6 volts or all digits do not emit light, and the batteries are properly installed, recharging is required.

A couple of days of intermittent operation are possible using zinc-carbon or alkaline C size batteries.



FRONT VIEW



REAR VIEW

Figure 4-1. Front and Rear Panel Views

AC OPERATION AND RECHARGING

1. Range switch is the power control. Power is applied to all indexed positions except OFF.
   NOTE: Nickel cadmium batteries must be properly installed for AC operation and recharging.
2. Plug battery charger into rear of DMM and power outlet. The instrument can be connected to the power line indefinitely. The plug on the battery compartment is polarized. Caution should be observed to avoid damaging the connectors.
3. If batteries are discharged below 4.6 volts, set range switch to OFF and connect to power line for at least five minutes before operating.
4. Recharge time of batteries is at least 16 hours with range switch set to OFF. Recharge rate is nominally 20% of full rate while instrument is being operated.

FUNCTION AND RANGE SELECTION

The following table shows function and switch positions for operation.

Function	*Range Switch Position*	*AC Push Button Switch Position*	*mA Push Button Switch Position*	*Notes*
Battery Test	TEST	OUT	OUT	—
Ω	Ω	OUT	OUT	1,3,4
DCV	200mV or V	OUT	OUT	1,2
ACV	200mV or V	IN	OUT	1,5
DC mA	200μA	OUT	IN	1
AC mA	200μA	IN	IN	1,5

NOTES:

1. On line operation, do not float the meter more than 1500V RMS above power ground.
2. When the input leads are open circuited on either 200mV DC or 2V DC, the display will slowly drift off to an overrange indication due to input bias current.
3. The application of an external negative voltage in the ohms function will cause the input fuse to blow.
4. On the 200.0Ω range, test lead and contact resistance will produce a zero offset of a few counts. The user can either null this out with ZERO set control or subtract the offset from all readings.
5. Reversing the charger plug in the power line may be necessary to avoid offset near zero with a floating input on some AC ranges.

ZERO ADJUSTMENT

1. Set range switch to 200mV.
2. Set AC pushbutton switch in DC position (button OUT).
3. Short input leads.
4. Adjust ZERO set control for .0 or ±.0 indication.

OVERRANGE DISPLAY

Blinking 1 in the most significant digit, balance of digits blanked.

INPUT OVERLOAD PROTECTION

The + input jack has a 1/32 amp fuse to protect against overloads in either ohms or mA functions. This fuse is replaceable from outside the case. See Figure 4-2. The wrench is at the tip of either of the two thumb screws used to retain the battery compartment.

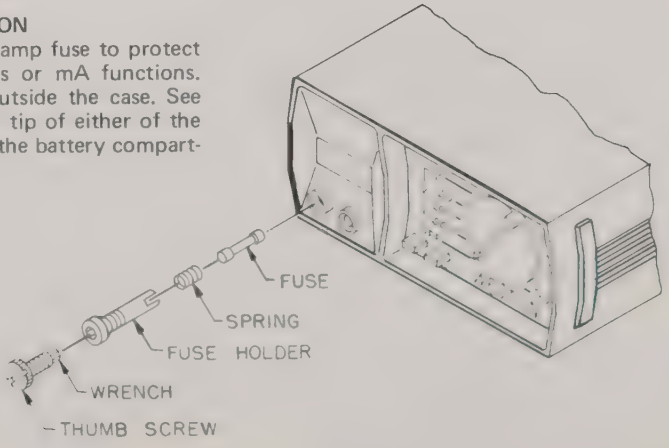


Figure 4-2. Input Fuse Replacement

SECTION 5

THEORY OF OPERATION

INTRODUCTION

This section presents the design and operating principles of the Weston 4440 Digital Multimeter. The theory of operation is presented at the functional level immediately below and in greater detail in the paragraphs following. Complete schematic diagrams and assembly drawings are included for reference in Section 7.

Model 4440 incorporates all circuitry needed to make measurements of DC voltage and current, AC voltage and current, and resistance. The basic measuring circuit is a high impedance bipolar analog to digital converter operating on the dual-slope principle. It has a measurement range of either 200mV or 2 volts DC, depending on the range switch setting. All inputs other than DC volts are converted to DC volts for measurement by this circuit.

Resistance is measured by passing a scaled constant current through the unknown and measuring the DC voltage across it. Alternating voltages are converted to DC by an average sensing, RMS calibrated converter assembly. Full scale output voltage for all ranges is 200mV DC. Current is measured by the voltage drop across a shunt. If DC, it is measured directly. If AC, DC blocking follows the shunt. Full scale shunt voltage is 200 millivolts.

The DC voltmeter and the several conversion circuits are interconnected by two push button switches and a rotary range switch which makes possible decimal point switching, input ranging, gain changes in the A/D converter, and shared usage of the precision attenuator. Interconnection information is presented in the schematic diagrams in Section 7 and the interested user will be better equipped to follow it after first digesting the operating theory of the functional parts that follows.

We have started with the A/D converter, that circuit being basic to all other modes. Then the front-end analog circuitry including attenuator and switching which complete the DC voltmeter circuit. Resistance, current, and AC converter, and power supply follow in that order.

The following paragraphs will present the theory of operation of the DC voltmeter and the several conversion circuits. Figure 5-1 shows the digital multimeter's circuit partitioning.

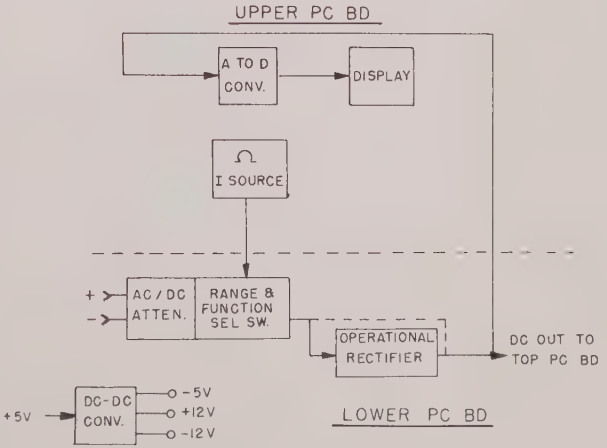


Figure 5-1. Circuit Partitioning

DETAILED CIRCUIT DESCRIPTION

DC VOLTMETER CIRCUIT

The A/D converter is common to all measuring functions. The input voltage may be either 200mV DC or 2 volts DC depending on range setting. All the voltages are scaled to one of these ranges by suitable attenuators, shunts, or converters. The display has a maximum reading of 1999 accompanied by decimal points, polarity sign and an overrange indication.

The circuit operation will be explained with the aid of Waveforms Figure 5-2 and the Block Diagram Figure 5-3.

DUAL SLOPE A/D CONVERSION

Dual slope is an integrating method of A/D conversion which has the following inherent advantages:

1. By proper choice of oscillator frequency, the effect of power frequency interference is reduced.
2. Internal conversion clock frequency accuracy is unimportant since amplitude is converted into a ratio of two time intervals.
3. Comparator threshold accuracy is unimportant.

The technique employed in the Model 4440 has the added advantage of not switching the input signal, eliminating a source of noise which can disturb the quantity being measured.

Figure 5-2 shows the waveforms associated with one conversion cycle. The equation relating Ein to a time ratio is as follows:

$$\frac{Ein\ T_1}{RC} = \left[I_{REF} - Ein/R\right] \frac{T_2}{C}$$

Since $T_1 + T_2 = T$

$$T_2 = Ein \frac{T}{I_{REF}\ R}$$

$$Ein = \frac{T_2}{T_1 + T_2} I_{REF} R$$

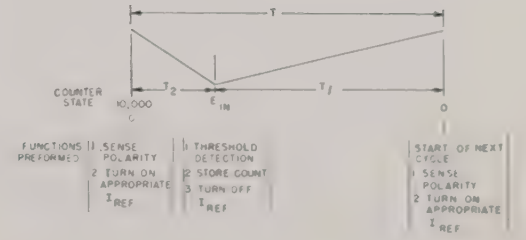


Figure 5-2. Waveforms

Figure 5-3 is a block diagram of the A/D converter.

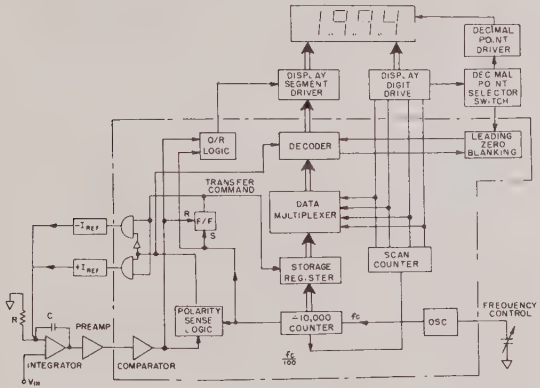


Figure 5-3. Block Diagram

DC VOLTMETER

Basic Logic

The A/D converter logic is incorporated on an MOS-LSI circuit. This includes the portion of the block diagram enclosed in dotted lines. The conversion period is fixed at 10,000 clock pulses. With a count advance from 9999 to 0000, the polarity of the integrator output is sensed and stored. Additionally, one of two current references is turned on based on the polarity data. When a comparator threshold is reached, the current reference is turned off, and prior to a new counter advance, the counter states are stored in a register. Meanwhile the counter continues counting.

Strobed Display Operation

The display digits are sequentially energized with each digit updated approximately 100 times per second. The digit-select logic output and the seven (7) segment logic outputs are synchronously supplied by the LSI circuit. See Figure 5-4. Segments are energized on a 10% duty cycle basis to enhance the LED display efficiency.

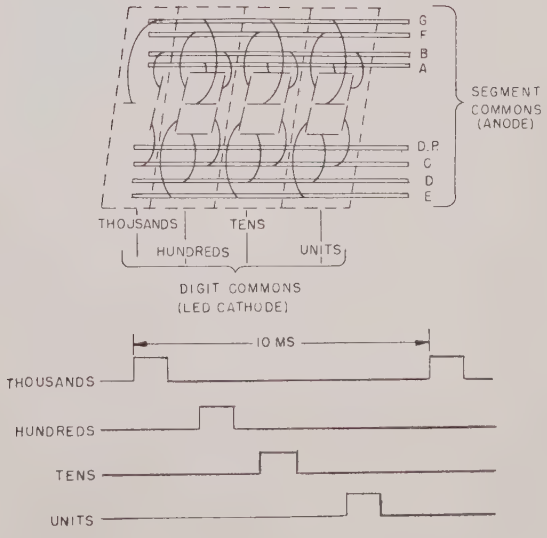


Figure 5-4. Display Strobing

The Non-Inverting Integrator

The basic integrator circuit, Figure 5-5, consists of an operational amplifier connected in the non-inverting mode for high-input impedance, and the logic-controlled current source necessary for controlling ramp action, as described in the previous paragraph. If, for example, an input voltage of +100mV is applied, the feedback amplifier causes point A to rise to 100mV producing a current through resistor R. In the absence of a reference current, this constant current charges capacitor C and point B will rise linearly to support this charge rate.

When, at the count of 10,000, a reference current is switched into point A, the reference source will supply the current through R and the remaining current will discharge capacitor C. Point B will then fall back towards zero taking 1,000 clock bits to do this, giving a display of 100.0. Since one complete period is 10,000 counts, the rise will consume 9,000 and the fall 1,000. Other input voltages will give rise to corresponding fall times and displays.

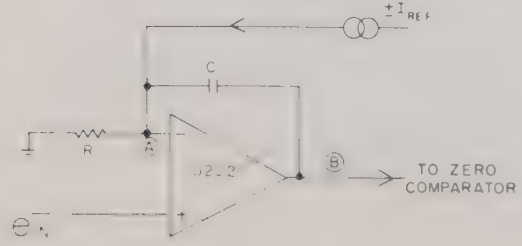


Figure 5–5. Integrator Circuit

Offset Adjustment

Offset voltages in U202, if not compensated, would produce a continuous ramp at B, even with zero input, and the display would stabilize at some small, non-zero reading. To compensate for offset voltage, the ground end of the integrating resistor is returned to an adjustable voltage, low-impedance, source as shown in figure 5-6.

Resistor R231 and its associated resistors provide a 50 ohm source, adjustable to±8mV to accommodate an 8mV possible offset voltage in the amplifier. The offset adjustment need not be changed when changing ranges.

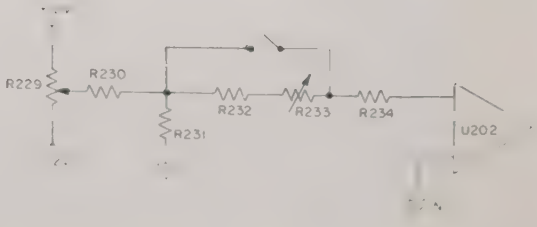


Figure 5-6. Offset Adjustment

Input Attenuation

On the 200mV, 2V, and 200μA ranges, Ein is applied without attenuation. See Figure 5-7. Impedance is provided to assure the integrator a fixed sink impedance, and to absorb overloads. A common attenuator is used for both AC and DC measurements on other voltage ranges. See Figure 5-8.

Back to back zeners provide overload protection. A 2 pole RC network provides filtering for normal mode rejection.

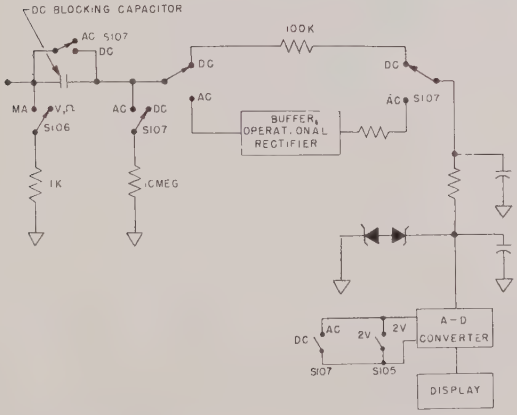


Figure 5-7. 200mV, 2V and Current Ranges

Reference Current Circuits

The reference current generators consist of a common-base transistor constant current source, and is illustrated in Figure 5-9 for the case of the positive reference.

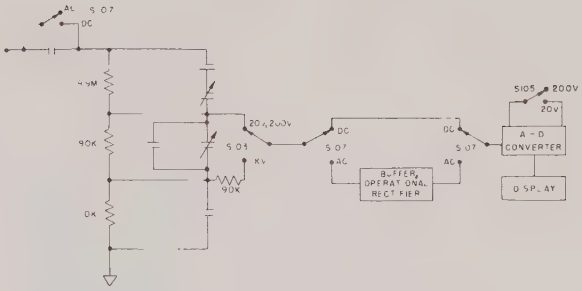


Figure 5-8. 20V, 200V and IKV Ranges

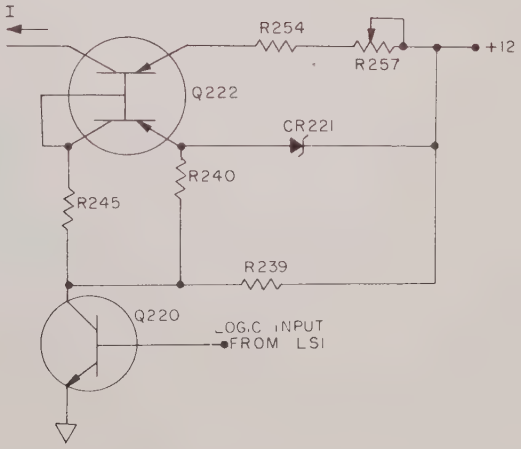


Figure 5-9. Reference Current Circuit

AC Buffer and Operational Rectifier (AC Converter)

The measurement of alternating voltages is accomplished by an average sensing, RMS calibrated, operational rectifier. It is essentially a half-wave rectifier, supported by:

An operational amplifier	to effectively sharpen the diode switching characteristic
Gain control	to introduce the 1.11 conversion factor between average and RMS
Output filtering .	to filter out the ripple component before applying the resultant DC voltage to the A/D converter
A high input impedance follower circuit	to buffer the operational rectifier from source impedance variations introduced by the attenuator

These circuit elements are shown in simplified form in Figure 5-10. Tracing signal flow from input terminal through to the A/D converter the following circuit functions are encountered:

1. At the input is a clamp network formed by two low leakage, low capacitance diodes. The input resistor and the diodes protect the FET buffer stage in case of inadvertent application of destructive voltages.
2. A FET/bipolar follower circuit provides high input impedance and low output impedance at approximately unity gain.
3. Following the buffer circuit is the input network of the operational rectifier. Voltages of 200mV or 2 volts, either direct input or derived from the attenuator are converted into input currents of 20 microamperes RMS. The input network switches in value from 10K to 100K respectively to maintain full scale input current at the 20 microampere level.
4. The operational rectifier provides sharp half-wave rectification and gain. Positive half cycles of the input waveform produce a negative half-wave rectified sine wave at point B. Negative half cycles produce a positive half-wave rectified sine wave at point A. Subsequent multistage RC filtering of the waveform at point A leaves only the DC component.
5. The half wave rectified sine wave at point A is filtered by a three pole low pass filter, designed to minimize ripple content without introducing excessive response-time delays. The source impedance seen by the A/D converter, looking back into the low pass filter is 100K, so as to maintain the source impedance balance required for good zero-stability, by the A/D converter.

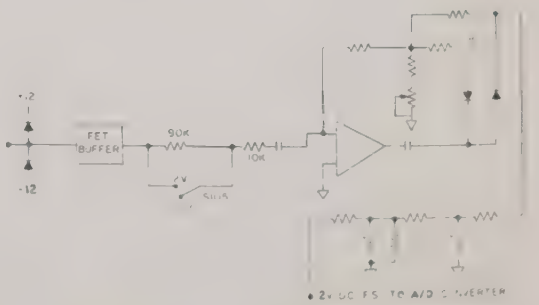


Figure 5-10. AC Converter Circuit

Ohms Circuit

The ohms of circuit is arranged as shown in Figure 5-11. Fuse F102, diodes CR116 and CR115, and resistor R120 form a protection network for the current reference source. The A/D converter is protected with the zener network described in the Input Attenuation paragraph.

Power Supply

The battery charger and battery supply are shown in Figure 5-12. The step-down transformer and fuse provide current limiting resistance for charging. Diode CR121 provides half-wave rectification. The nominal +5V is used directly by the following:

1. LED display
2. AC converter operational amplifier
3. Logic

A DC-DC converter is used to generate −5 volts, +12 volts, and −12 volts. The −5 volts is used only by the AC converter operational rectifier.

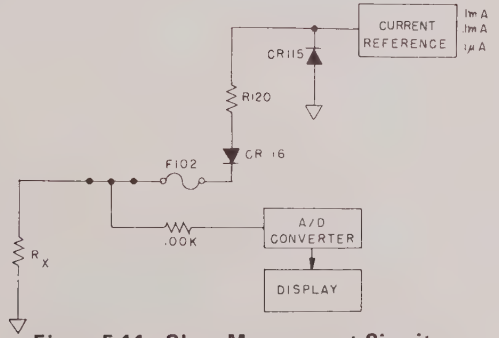


Figure 5-11. Ohms Measurement Circuit

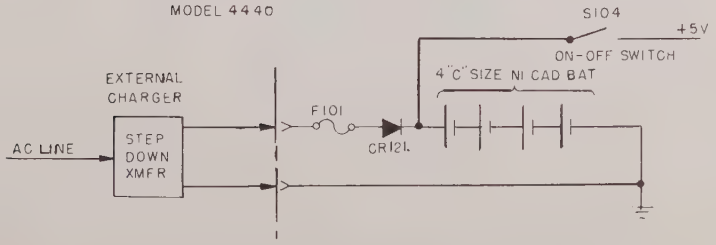


Figure 5–12. AC Line/Battery Operation

SECTION 6

MAINTENANCE

CALIBRATION

To calibrate the Model 4440, all adjustments are accessible without uncasing. The AC gain pot is on the rear, with the balance of the adjustments accessible when the dial plate is removed. The dial plate is removed by inserting the tip of a ball-point pen in the zero hole, and carefully prying up the plastic plate which snaps out. The adjustments are identified as shown in Figure 6-1, (numbers 1 through 9 inclusive).

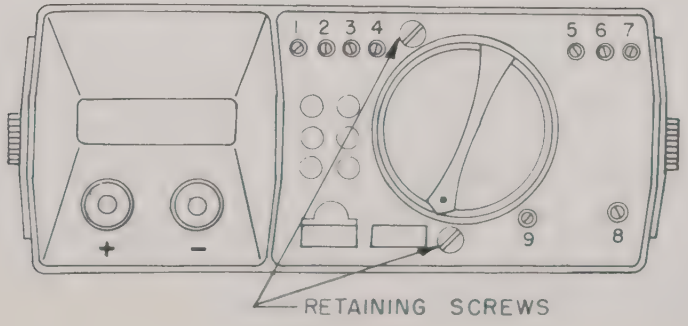


Figure 6-1. Calibration

Performance Check (25°)	Corrective Action
1. Charger circuit fuse: With line operation, the battery voltage should stabilize above 5.0 volts with sustained usage.	Replace fuse F101 (See Figure 6-2).
2. Input fuse: Short the input on the 200 mV DC range. Zero should appear.	Replace fuse F102 (See Fig. 4-2). Adjust zero. (R229 or adjustment No.1 on front panel).
3. Reference adjustments: (a) Apply +190.0 mV DC on 200 MV DC range	Adjust R257 (adjustment No.2 on front panel) until display reads correctly.
(b) Apply −190.0 mV DC on 200 MV DC range.	Adjust R247 (adjustment No.3 on front panel) until display reads correctly.
4. DC gain control: Apply 1.900 volts DC on the 2 volt range.	Adjust R233 (adjustment No.7 on front panel) until display reads correctly.
5. 2 megohm and 200KΩ: Apply a 1.900 MΩ/190.0KΩ resistor to the input.	Adjust R241 (adjustment No.4) until display reads correctly. Split any deviations in moving back and forth between the two ranges.
6. 20KΩ: Apply a 19.00 KΩ resistor to the input.	Adjust R259 (adjustment No.5 on front panel) for correct display.
7. 2KΩ: Apply a 1.900 KΩ resistor to the input.	Adjust R258 (adjustment No.6 on front panel) for correct display.
8. 200 mV AC: Apply 190.0 mV (50 Hz) — 1K Hz)	Adjust R146 (adjustment on rear of case) for correct display
9. 1000 VAC attenuator compensation: Apply 1000 VAC at 2K Hz	Adjust C103 (adjustment No.9 on front panel) to 1000 ±2 counts.
10. 20 VAC attenuator compensation: Apply 19.00 VAC at 8K Hz	Adjust C106 (adjustment No.8 on front panel) to 19.00 ±2 counts.
Repeat steps 9 and 10.	
11. Ohms circuit stays at zero.	Replace input fuse F102.

BATTERY ACCESSIBILITY

Although nickel cadmium cells typically provide years of service, it is possible that battery operation will be required with insufficient time for adequate recharging. In this event either four zinc-carbon or four previously charged C size batteries can be used.

Protection is provided to prevent damage to circuitry if batteries are installed with incorrect polarity. A fuse will blow if the batteries are improperly installed when the charger is connected to both the DMM and the power line.

Either to reach the batteries or to replace the charger circuit fuse, the battery compartment must be removed. See Figure 6-2.

Fuse access only:

1. Remove two thumb screws.
2. Screw one of the thumb screws on recessed stud grasping DMM case with one hand, gently ease out the battery compartment, using the inserted thumb screw as a grip.

Battery and spare fuse access:

3. Slide out the battery covers.
4. Slip out battery jumper straps.
5. Slide the cells from their compartments.

Reverse the above sequence for assembly.

Battery polarity markings are molded in to both ends of each cell compartment. Battery cover slides must be fully inserted to permit proper installation of the battery pack.

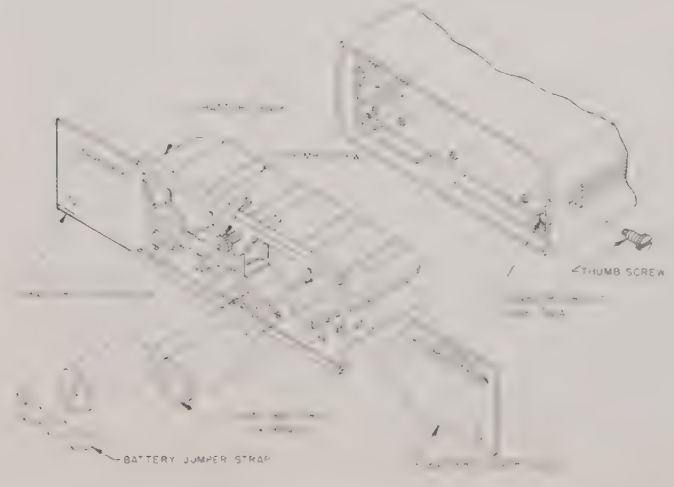


Figure 6-2. Battery Accessibility

SECTION 7

DRAWINGS AND PARTS LIST

This section contains drawings, schematic diagrams and parts list for the instrument.

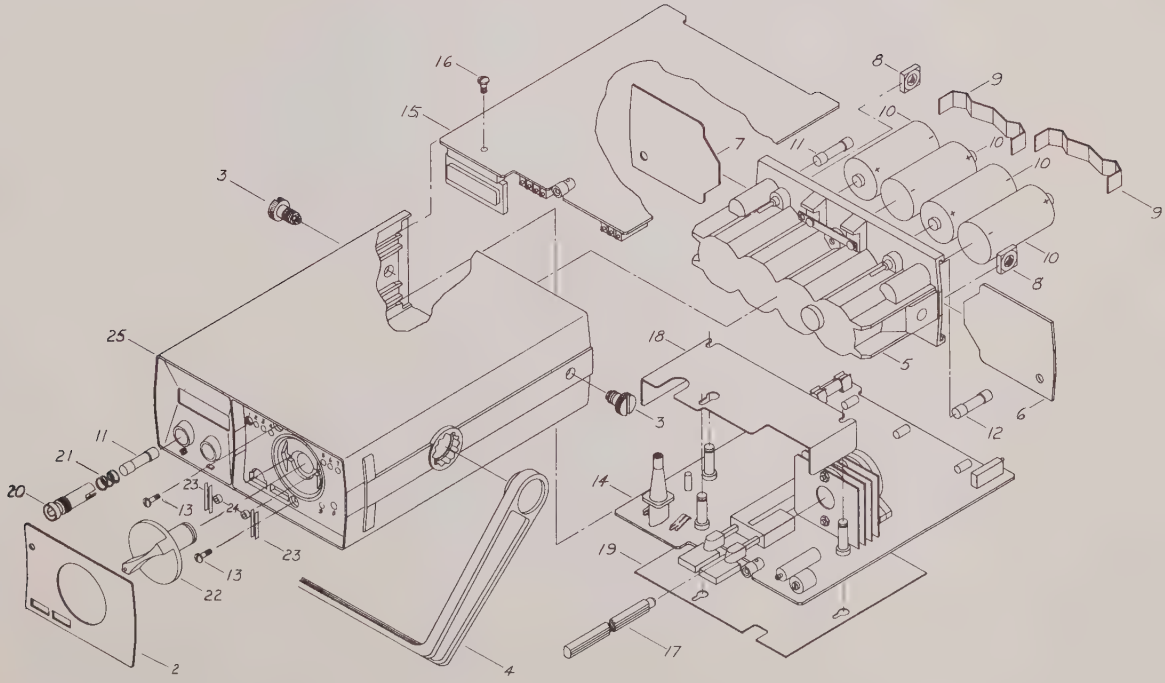


Figure 7-1. Assembly

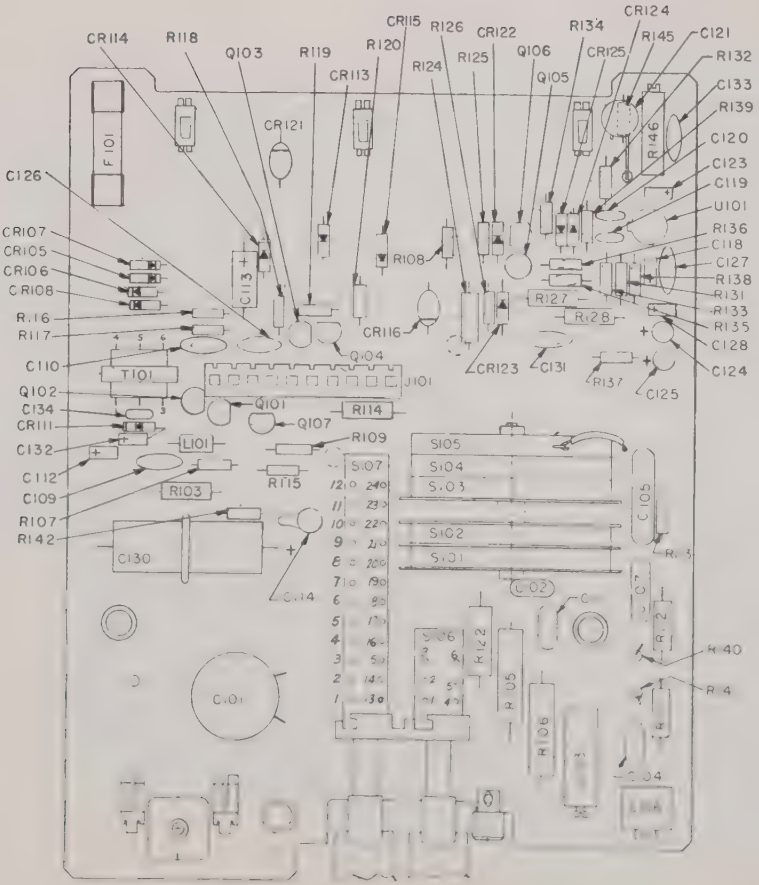


Figure 7-2. Lower Board Assembly

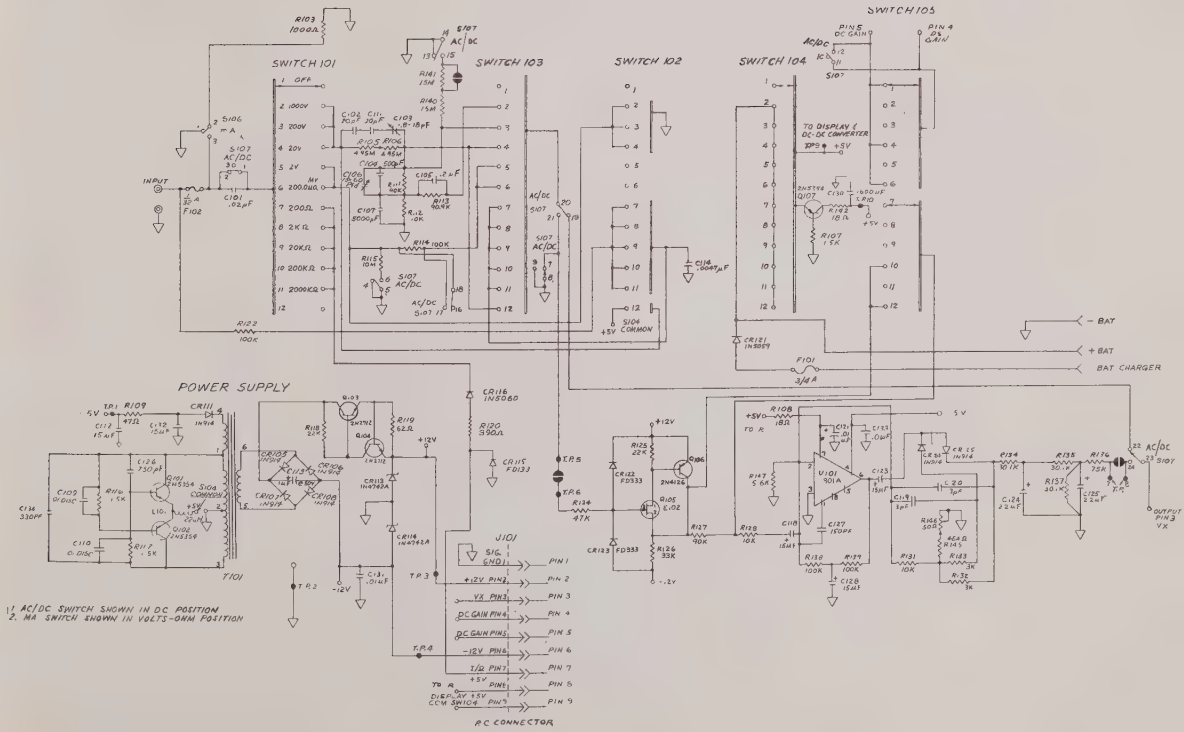


Figure 7-3. Schematic Diagram, Lower Board

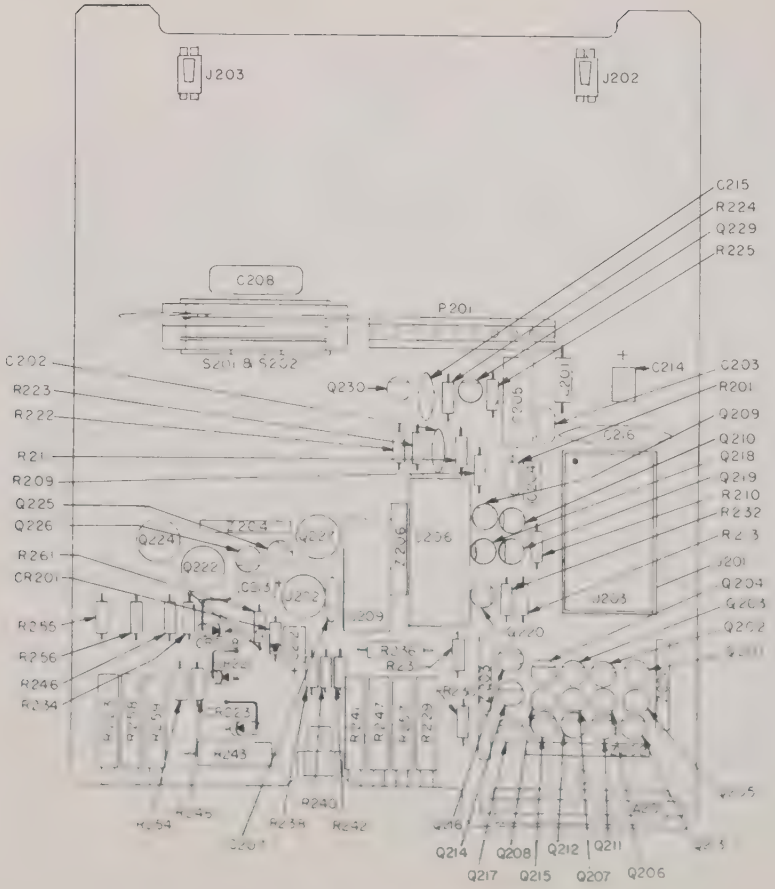


Figure 7-4. Upper Board Assembly

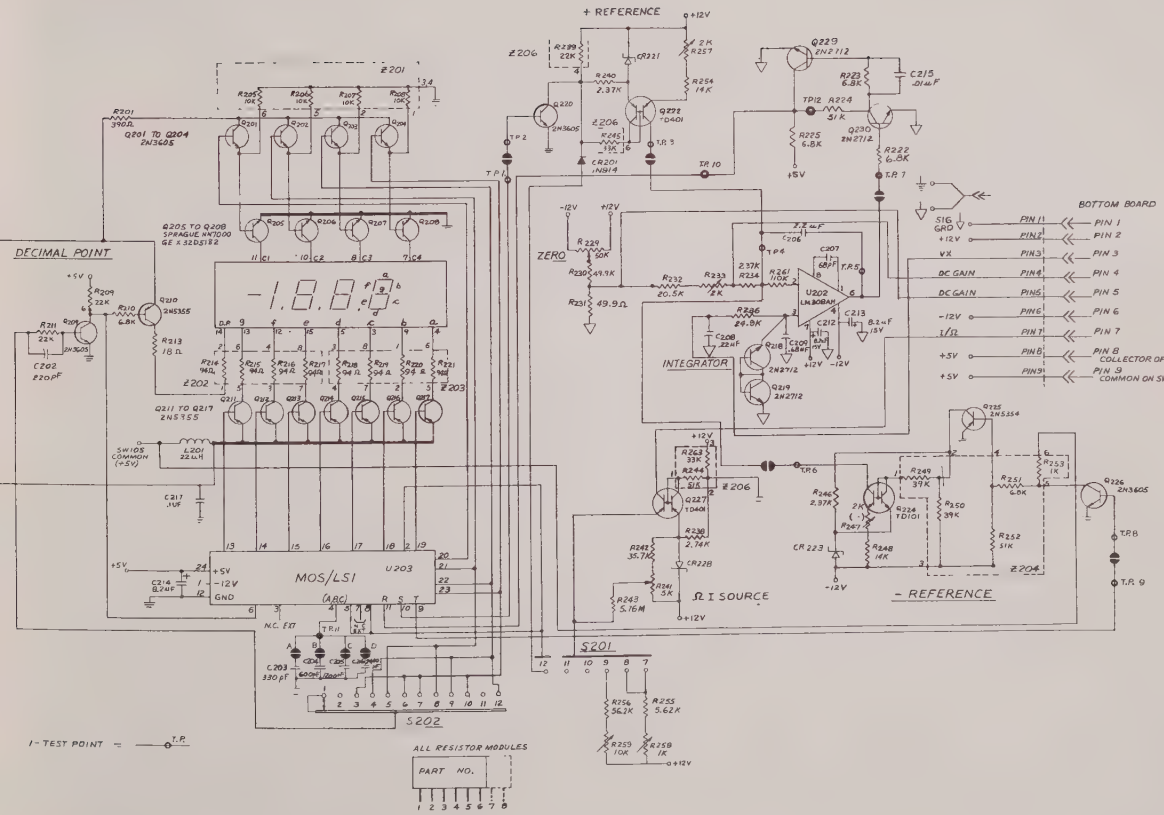


Figure 7-5. Schematic Diagram, Upper Board

ITEM NO.	DESCRIPTION	WESTON PART NO.
	ASSEMBLY (Ref Figure 7-1)	
1	DIGITAL MULTIMETER	273160
2	DIAL, PRINTED	272151-901
3	SCREW, THUMB	272142-024
4	HANDLE	272121-001
5	CASE ASSY, BATTERY	272975-901
6	COVER, BATTERY	273039-901
7	COVER, BATTERY	273039-902
8	NUT, BATTERY CASE MTG	272143-001
9	CONTACT, BATTERY SHORTING	272970-024
10	BATTERY, C SIZE, NiCad, 1.2V	274120-001
11	FUSE, 0.031A, 8AG	ND26368-001
12	FUSE, 0.750A, 8AG	274142-001
13	SCREW, BOARD MTG	ND39831-024
14	BOARD ASSY, LOWER	272117-901
15	BOARD ASSY, DIGITAL, UPPER	272120-901
16	SCREW	ND40586-024
17	SHAFT, RANGE SWITCH	269436-001
18	SHIELD, COVER	272141-024
19	SHIELD, AC COVER, OUTSIDE	272154-001
20	SOCKET, FUSE	272134-024
21	SPRING	271054-024
22	KNOB	267331-901
23	SPRING, DETENT	267333-001
24	ROLLER, DETENT	267334-001
25	CASE, PAINTED	272149-901
-	HARDWARE, PANEL MTG	187205-953
–	LEAD ASSY	270066-001
–	BATTERY CHARGER, 105-130V 50-400Hz	272968-901
–	BATTERY CHARGER, 210-260V 50-400Hz	273426-901

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	LOWER BOARD ASSY (Ref Figures 7-2 & 7-3)	
C101	CAPACITOR 0.02 μF, ±20%, 1000 WVDC	274106-001
C102	CAPACITOR, 20 pF, ±5%, 500 WVDC	272747-001
C103	CAPACITOR, .8-10 pF, 750 WVDC	274103-001
C104	CAPACITOR, 470,pF, ±5%, 500 WVDC	270012-001
C105	CAPACITOR, .22 μF, ±20%, 250 WVDC	272263-001
C106	CAPACITOR, 10-60 pF, 250 WVDC	270081-001
C107	CAPACITOR, 5000 pF, ±5%, 100 WVDC	270011-001
C109	CAPACITOR, .01 μF, ±20%, 100 WVDC	ND37639-001
C110	CAPACITOR, .01 μF, ±20%, 100 WVDC	ND37639-001
C111	CAPACITOR, 20 pF, ±5%, 500 WVDC	272747-001
C112	CAPACITOR, 15μF, ±20%, 10 WVDC	269951-001
C113	CAPACITOR, 1μF,±20%, 50 WVDC	272897-001
C114	CAPACITOR, .0047 μF, −20%, +50%, 125 WVDC	269898-001
C118	CAPACITOR, 15 μF, ±20%, 10 WVDC	269951-001
C119	CAPACITOR, 3 pF, ±1 pF, 300 WVDC	269947-001
C120	CAPACITOR, 3 pF, ±1 pF, 300 WVDC	269947-001
C121	CAPACITOR, .01 μF,±20%, 100 WVDC	ND37639-001
C123	CAPACITOR, 15 μF, ±20%, 10 WVDC	269951-001
C124	CAPACITOR, 2.2 μF, ±20%, 15 WVDC	274118-001
C125	CAPACITOR, 2.2 μF, ±20%, 15 WVDC	274118-001
C126	CAPACITOR, 750,pF, ±10%, 1000 WVDC	274154-001
C127	CAPACITOR, 150 pF, ±10%, 1000 WVDC	274101-001
C128	CAPACITOR, 15 μF, ±20%, 10 WVDC	269951-001
C130	CAPACITOR, 1600 μF, +50%, −10%, 10 WVDC	266607-001
C131	CAPACITOR, .01 μF, ±20%, 100 WVDC	ND37639-001
C132	CAPACITOR, 15 μF ±20%, 10 WVDC	269951-001
C133	CAPACITOR, .01 μF, ±20%, 100 WVDC	ND37639-001
C134	CAPACITOR, 330 pF, ±10%, 1000 WVDC	270044-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	LOWER BOARD ASSY (Ref Figures 7-2 & 7-3) [continued]	
CR105	DIODE, 1N914	ND61025-001
CR106	DIODE, 1N914	ND61025-001
CR107	DIODE, 1N914	ND61025-001
CR108	DIODE, 1N914	ND61025-001
CR111	DIODE, 1N914	ND61025-001
CR113	DIODE, 1N4742A	264601-001
CR114	DIODE, 1N4742A	264601-001
CR115	DIODE, FD333	269922-001
CR116	DIODE, 1N5060	266591-001
CR121	DIODE, 1N5059	266611-001
CR122	DIODE, FD333	269922-001
CR123	DIODE, FD333	269922-001
CR124	DIODE, 1N914	ND61025-001
CR125	DIODE, 1N914	ND61025-001
F101	FUSE, 3/4A, 8AG	274142-001
J101	CONNECTOR	274121-001
L101	CHOKE, 22 μH ±10%	274145-001
Q101	TRANSISTOR, 2N5354	268795-001
Q102	TRANSISTOR, 2N5354	268795-001
Q103	TRANSISTOR, 2N2712	ND39917-001
Q104	TRANSISTOR, 2N2712	ND39917-001
Q105	TRANSISTOR, E102	269958-001
Q106	TRANSISTOR, 2N4126	269956-001
Q107	TRANSISTOR, 2N5354	268795-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	LOWER BOARD ASSY (Ref Figures 7-2 & 7-3) [continued]	
R103	RESISTOR, 1K ohms ±0.1%	272895-001
R105	RESISTOR, 4.95M ohms	
R106	RESISTOR, 4.95M ohms } Matched	272838-001
R111	RESISTOR, 90K ohms } Set	
R112	RESISTOR, 10K ohms	
R107	RESISTOR, 1.5K ohms ±5%, 1/4 watt	264677-001
R108	RESISTOR, 18 ohms ±5%, 1/4 watt	272245-001
R109	RESISTOR, 47 ohms ±5%, 1/4 watt	272716-001
R113	RESISTOR, 90.9K ohms ±1%	272210-001
R114	RESISTOR, 100K ohms ±1%	266313-001
R115	RESISTOR, 10M ohms ±5%, 1/4 watt	274158-001
R116	RESISTOR, 1.5K ohms ±5%, 1/4 watt	264677-001
R117	RESISTOR, 1.5K ohms ±5%, 1/4 watt	264677-001
R118	RESISTOR, 22K ohms ±5%, 1/4 watt	264674-001
R119	RESISTOR, 62 ohms ±5%, 1/4 watt	274184-001
R120	RESISTOR, 390 ohms ±5%, 1/4 watt	272246-001
R122	RESISTOR, 100K ohms, ±1%	266446-001
R124	RESISTOR, 47K ohms ±5%, 1/2 watt	ND20594-001
R125	RESISTOR, 22K ohms ±5%, 1/4 watt	264674-001
R126	RESISTOR, 33K ohms ±5%, 1/4 watt	269869-001
R127	RESISTOR, 90K ohms } Matched	
R128	RESISTOR, 10K ohms } Set	272853-001
R131	RESISTOR, 10K ohms ±1%, 1/10 watt	266627-001
R132	RESISTOR, 3.01K ohms ±1%, 1/10 watt	272217-001
R133	RESISTOR, 3.01K ohms ±1%, 1/10 watt	272217-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	LOWER BOARD ASSY (Ref Figures 7-2 & 7-3) [continued]	
R134	RESISTOR, 30.1K ohms ±1%, 1/10 watt	269931-001
R135	RESISTOR, 30.1K ohms ±1%, 1/10 watt	269931-001
R136	RESISTOR, 75K ohms ±1% 1/10 watt	272211-001
R137	RESISOTR, 30.1K ohms ±1%, 1/10 watt	269931-001
R138	RESISTOR, 100K ohms ±5%, 1/4 watt	266592-001
R139	RESISTOR, 100K ohms ±5%, 1/4 watt	266592-001
R140	RESISTOR, 15M ohms ±5%, 1/4 watt	266653-001
R141	RESISTOR, 15M ohms ±5%, 1/4 watt	266653-001
R142	RESISTOR, 18 ohms ±5%, 1/4 watt	272245-001
R145	RESISTOR, 464 ohms ±1%, 1/10 watt	266634-001
R146	RESISTOR, VARIABLE, 50 ohms ±10%	272894-001
R147	RESISTOR, 5.6K ohms ±5%, 1/4 watt	265819-001
S101 thru S105	SWITCH ASSY, RANGE	272147-901
S106 & S107	SWITCH ASSY, PUSH BUTTON	272850-001
T101	TRANSFORMER	272155-901
U101	AMPLIFIER, LM301A	272691-001
–	BOARD ASSY, HARDWARE	272117-902
–	BUTTON, PUSH	272124-001

UPPER BOARD ASSY (Ref Figures 7-4 & 7-5)

REF SYMBOL	DESCRIPTION	WESTON PART NO.
A201	DISPLAY ASSY, L.E.D.	272114-902
C202	CAPACITOR, 220 pF, ±10%, 1000 WVDC	264091-001
C203	CAPACITOR, 330 pF, ±10%, 1000 WVDC	270044-001
C204	CAPACITOR, 600 pF, ±10%, 500 WVDC	274133-001
C205	CAPACITOR, 1200 pF, ±10%, 500 WVDC	274132-001
C206	CAPACITOR, 2.2 μF, ±10%, 250 WVDC	274131-001
C207	CAPACITOR, 68 pF, ±10%, 1000 WVDC	272422-001
C208	CAPACITOR, .22μF, ±20%, 250 WVDC	272263-001
C209	CAPACITOR, .68 μF, ±10%, 250 WVDC	274110-001
C212	CAPACITOR, 8.2 μF, ±20%, 15 WVDC	269952-001
C213	CAPACITOR, 8.2 μF, ±20%, 15 WVDC	269952-001
C214	CAPACITOR, 8.2 μF, ±20%, 15 WVDC	269952-001
C215	CAPACITOR, .01 μF, ±20%, 100 WVDC	ND37639-001
C216	CAPACITOR, 2400 pF, ±10%, 500 WVDC	274156-001
CR201	DIODE, 1N914	ND61025-001
CR221	DIODE, ZENER, TEMP COMPENSATED	274203-001
CR223	DIODE, ZENER, TEMP COMPENSATED	274203-001
CR228	DIODE, ZENER, TEMP COMPENSATED	274203-001
J201	SOCKET, RECEPTACLE LSI	272738-077
J202 & J203	SOCKET, Molex 1850A3	269945-001
J204	DISPLAY, RECEPTACLE	272847-001
L201	CHOKE, 22 μH, ±10%	274145-001
P201	PLUG, INTERCONNECTION	272977-001
Q201	TRANSISTOR, 2N3605	268796-001
Q202	TRANSISTOR, 2N3605	268796-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	UPPER BOARD ASSY (Ref Figures 7-4 & 7-5) [continued]	
Q203	TRANSISTOR, 2N3605	268796-001
Q204	TRANSISTOR, 2N3605	268796-001
Q205	TRANSISTOR	272896-001
Q206	TRANSISTOR	272896-001
Q207	TRANSISTOR	272896-001
Q208	TRANSISTOR	272896-001
Q209	TRANSISTOR, 2N3605	268796-001
Q210	TRANSISTOR	272893-001
Q211	TRANSISTOR	272893-001
Q212	TRANSISTOR	272893-001
Q213	TRANSISTOR	272893-001
Q214	TRANSISTOR	272893-001
Q215	TRANSISTOR	272893-001
Q216	TRANSISTOR	272893-001
Q217	TRANSISTOR	272893-001
Q218	TRANSISTOR, 2N2712	ND39917-001
Q219	TRANSISTOR, 2N2712	ND39917-001
Q220	TRANSISTOR, 2N3605	268796-001
Q222	TRANSISTOR, TD401A	269904-001
Q224	TRANSISTOR, TD101A	266399-001
Q225	TRANSISTOR, 2N5354	268795-001
Q226	TRANSISTOR, 2N3605	268796-001
Q227	TRANSISTOR, TD401A	269904-001
Q229	TRANSISTOR, 2N2712	ND39917-001
Q230	TRANSISTOR, 2N2712	ND39917-001
R201	RESISTOR, 390 ohms ±5%, 1/4 watt	272246-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	UPPER BOARD ASSY (Ref Figures 7-4 & 7-5) [continued]	
R209	RESISTOR, 22K ohms ±5%, 1/4 watt	264674-001
R210	RESISTOR, 6.8K ohms ±5%, 1/4 watt	269891-001
R211	RESISTOR, 22K ohms ±5%, 1/4 watt	264674-001
R213	RESISTOR, 18 ohms ±5%, 1/4 watt	272245-001
R222	RESISTOR, 6.8K ohms ±5%, 1/4 watt	269891-001
R223	RESISTOR, 6.8K ohms ±5%, 1/4 watt	269891-001
R224	RESISTOR, 51K ohms ±5%, 1/4 watt	272247-001
R225	RESISTOR, 6.8K ohms ±5%, 1/4 watt	269891-001
R229	RESISTOR, VARIABLE, 50K ohms, ±10%	272858-001
R230	RESISTOR, 49.9K ohms ±0.1%	269884-001
R231	RESISTOR, 49.9 ohms ±5%, 1/4 watt	269886-001
R232	RESISTOR, 20.5K ohms ±0.1%	274138-001
R233	RESISTOR, VARIABLE, 2K ohms, ±10%	272869-001
R234	RESISTOR, 2.37K ohms ±0.1%	274140-001
R236	RESISTOR, 24.9K ohms ±0.1%	272868-001
R238	RESISTOR, 2.74k ohms ±0.1%	272863-001
R240	RESISTOR, 2.37K ohms ±0.1%	274140-001
R241	RESISTOR, VARIABLE, 5K ohms, ±10%	269919-001
R242	RESISTOR, 35.7K ohms, ±0.1%	270158-001
R243	RESISTOR, 5.76 megohms, ±1%	274155-001

REF SYMBOL	DESCRIPTION	WESTON PART NO.
	UPPER BOARD ASSY (Ref Figures 7-4 & 7-5) [continued]	
R246	RESISTOR, 2.37K ohms, ±0.1%	274140-001
R247	RESISTOR, VARIABLE, 2K ohms, ±10%	272869-001
R248	RESISTOR, 14K ohms, ±0.1%	274139-001
R254	RESISTOR, 14K ohms, ±0.1%	274139-001
R255	RESISTOR, 5.62K ohms, ±0.1%	272864-001
R256	RESISTOR, 56.2K ohms ±0.1%	272899-001
R257	RESISTOR, VARIABLE, 2K ohms, ±10%	272869-001
R258	RESISTOR, VARIABLE, 1K ohms, ±10%	270162-001
R259	RESISTOR, VARIABLE, 10K ohms, ±10%	274181-001
R261	RESISTOR, 110K ohms, ±0.1%	270199-001
S201 & S202	SWITCH ASSY, RANGE	272146-901
U202	AMPLIFIER, LM308	271819-001
U203	INTEGRATED CIRCUIT, MOS-LSI	272612-001
Z201	RESISTOR, MODULE, 10K ohms	272156-001
Z202	RESISTOR, MODULE, 94 ohms	272157-001
Z203	RESISTOR, MODULE, 94 ohms	272157-001
Z204	RESISTOR, MODULE, –REF	272159-001
Z206	RESISTOR, MODULE, + Ref, Ω	262934 001

WESTON EQUIPMENT WARRANTY

Weston warrants equipment of its manufacture against defective materials or workmanship for a period of one year from date of shipment.

The liability of Seller under this warranty is limited, at Seller's option, solely to repair, replacement with equivalent Weston equipment, at an appropriate credit adjustment not to exceed the original equipment sales price, of equipment returned to the Seller provided that (a) Seller is promptly notified in writing by Buyer upon discovery of defects, (b) Upon receipt of written authorization from Seller the defective equipment is returned as directed, transportation charges prepaid by Buyer, and (c) Seller's examination of such equipment discloses to his satisfaction that defects were not caused by negligence, misuse, improper installation, accident, or unauthorized repair or alteration by the Buyer.

This warranty does not include mechanical parts failing from normal usage nor does it cover limited life electrical components which deteriorate with age such as tubes, lamps, etc.

This warranty is in lieu of all other warranties, expressed or implied, including the implied warranty of fitness for a particular purpose to the original purchaser or to any other person. Seller shall not be liable for consequential damages of any kind.

The aforementioned provisions do not extend the original warranty period of any article which has been either repaired or replaced by Seller.

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